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Patents ADP number *(if you know it)* 7777956003

If the applicant is a corporate body, give the country/state of its incorporation — UNITED KINGDOM

4. Title of the invention — PROCESSING FOR BINDING SHEETS

5. Name of your agent *(if you have one)* — STEVENS HEWLETT & PERKINS

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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Continuation sheets of this form	
Description	12
Claim(s)	5
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PROCESS FOR BINDING SHEETS

This invention relates to the field of printing, in particular to a process for binding individual sheets to form a book or section of a book.

Digital printing technology allows a printed image to be changed on each consecutive sheet supplied to the printer without stopping the printer to fit a new printing plate. This means that the sheets of a book can be printed in sequence. Digital printing therefore offers the potential for rapid collation of consecutive printed sheets into books or booklets. Alternative (more conventional) technologies, for example offset lithographic printers, adopt an approach in which each sheet of the book is printed a requisite number of times before moving to the next sheet. The individual sheets of the conventionally-printed book are only subsequently collated for binding. As a result of the ability to combine the printing and collation stages, digital printers are able to print short and medium sized runs of printed material far more quickly and at a lower cost than previously possible.

An in-line digital printing and book-binding apparatus is described in PCT patent application WO 01/34403A. In this, and other prior art digital printing systems, a continuous web is output from a printer that is digitally printed on both surfaces. To produce the finished book the printed web must be cut into sheets with each sheet forming two pages of the book printed on both sides. The individual sheets must then be folded, collated, covered, stitched and trimmed. The order of these operations may be varied, and this has led to the development of a variety of assemblies each suitable for implementing one or more process steps in the various stages of book production.

In conventional book binding machines, books are assembled by dropping different printed sheets onto a moving transport conveyor from a series of feed hoppers. By loading the first hopper with sheet 1, the second with sheet 2, etc., this ensures that the resulting piles of sheets formed on the transport conveyor contain sheets organised in the correct sequence. By way of contrast, digitally printed sheets are already output from the

printer in their correct order and this enables the benefits of a fixed-position sheet collector to be realised. Fixed-position collectors stop a first sheet and enable subsequent sheets to be delivered in turn one on top of the other. Once all the sheets for one book have been stacked together, the fixed-position collectors then transport the stack of sheets out of the collector. Compared with conventional sheet collectors, such fixed-position collectors are simpler, more reliable, have fewer moving parts, are less liable to malfunction and breakage and may be fed directly from the printer.

It is an object of the present invention to provide an alternative binding mechanism that is capable of offering an overall improvement to the quality of binding for digital production of books or booklets.

Accordingly the present invention provides a process for binding sheets together, the binding process comprising the steps of: feeding successive individual sheets to a folding apparatus; folding each sheet along a fold line; stacking successive sheets such that the fold lines of each sheet are substantially aligned characterised in that adhesive is applied to the fold line of the second and subsequent sheets prior to stacking and in that the adhesive is applied to the inside of the fold lines.

In an alternative aspect the present invention provides binding apparatus for binding sheets together, the apparatus comprising: sheet folding apparatus for individually folding sheets along a fold line; and a sheet collector for stacking successive sheets such that the fold lines of each sheet are substantially aligned characterised by further comprising an adhesive applicator arranged to apply adhesive to the inside of the fold line of the second and subsequent sheets prior to stacking.

Thus, with the present invention as adhesive is applied to the inside of the fold lines of each sheet prior to the sheets being stacked, the risk is significantly reduced of adhesive accidentally coming into contact with regions of a sheet other than its fold line. Moreover, the structure of the fold line in the sheet acts as a natural barrier to movement or flow of the adhesive away from the fold line.

Additionally, the present invention provides in a further aspect a

process for stacking folded printed sheets, the process comprising the steps of: feeding successive individual printed sheets to a folding apparatus; folding each sheet along a fold line; and stacking successive sheets such that the fold lines of each sheet are substantially aligned wherein the first sheet of a new stack is temporarily held above the stacking area by means of retractable fingers and characterised in that at least one of the retractable fingers is rotatable about an axis substantially transverse to the sheet transport direction.

In a further alternative aspect the present invention provides stacking apparatus for stacking folded printed sheets together such that the fold lines of each sheet are substantially aligned, comprising a collection arm on which individual sheets are collected in a stack and first and second retractable fingers arranged above the stacking area characterised in that at least one of the retractable fingers is rotatable about an axis substantially transverse to the sheet transport direction.

An embodiment of the invention will now be described by way of example only with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram of in-line binding apparatus in accordance with the present invention;

Figure 2 illustrates a first stage in the binding process of the present invention in which a flat printed sheet is folded along a central line;

Figure 3 illustrates a second stage in the binding process of the present invention in which glue is applied to a folded sheet;

Figure 4 illustrates a third stage in the binding process of the present invention in which glued sheets are collected on a sheet collector to form a book or part thereof;

Figure 5 is an end on view of a sheet transport extension for use in the in-line binding apparatus according to the present invention;

Figure 6 is an end on view of a pressing down anvil for use in the in-line binding apparatus according to the present invention; and

Figures 7a-7f show various stages in the sheet collection portion of the binding process.

Figure 1 illustrates an in-line book assembly apparatus in which printed sheets leaving a digital printer are carried by a conveyor, or other transport system, through assemblies adapted for the various stages of book construction.

The in-line book assembly apparatus includes a cutter for cutting a web 1 that previously has been digitally printed on both sides into individual sheets 2. Each sheet 2 is sized such that each sheet 2 has two pages printed on each surface. Once the individual sheets 2 have been cut they are transferred successively to a conveyor 4. The conveyor 4 delivers the individual sheets 2 to a pair of scoring wheels 5 which are positioned centrally above and below the conveyor 4 (only the upper scoring wheel is visible in Figure 1). The conveyor 4 includes an adjustable side guide 6 that is used to accurately align the centre of the sheet 2 with the scoring wheels 5. The centre line of each of the individual sheets 2, about which the sheets 2 are to be folded, is positioned by the side guide 6 so that the centre line lies parallel to the direction of travel of the sheet and is exactly aligned with the scoring wheels 5. Thus, as an individual sheet 2 passes though the pair of scoring wheels 5 the centre line of the sheet is accurately scored to define the fold line in the sheet 2.

Downstream from the scoring wheels 5, the in-line book assembly apparatus includes a sheet folding assembly 10 in which the individual sheets are folded in succession to form two pages of a book with each page having text printed on each side thereof. The sheet folding assembly 10 includes a series of folding belts 7,8 and a pair of nip wheels 9. The folding belts 7,8 are conventional in construction and arrangement, and consist of two upper, side belts 7 that are downwardly angled with respect to the feed direction and twisted inwardly towards a lower, central belt 8. In addition to folding the individual sheets the belts are also used to drive the pair of nip wheels 9. As a sheet 2 is carried forward by the folding belts 7,8 the side belts 7 urge the sides of the sheet inwards and downwards by virtue of the twist in the belts. A sheet 2 passing into the sheet folding assembly 10 is thus folded in half about its central fold line with each side

or page hanging down either side of the central belt 8. The pair of nip wheels 9 are provided immediately after the folding belts 7,8 to further sharpen the fold in the sheet 2. The nip wheels 9 are positioned so as to engage each side of the sheet 2 immediately adjacent the fold line and are arranged to press the sides of the sheet together.

Downstream of the sheet folding assembly 10 the in-line book assembly apparatus further includes a sheet transport extension 20. Each folded sheet 2 is fed to the sheet transport extension 20 after leaving the nip wheels 9. The sheet transport extension 20 applies glue to the inside of the fold line for every sheet, except the first sheet, of each book or portion of a book passing through the sheet folding assembly 10. As can be more clearly seen from Figure 5, the sheet transport extension 20, which is similar in structure to a saddle, incorporates two low friction support surfaces 21 and 22 which are separated along their upper edges by a slot 40 and arranged at an angle to each other such that they depend downwardly and outwardly from each other to form a broken inverted V-shape, in section. The sheet transport extension 20 also includes inner rotating rollers 44 and 45 and outer rotating rollers 44a and 45a which drive each sheet through the sheet transport extension 20 and guide each sheet 2 so that the fold line of each sheet passes over the slot 40.

A glue applicator 23, which also forms part of the sheet transport extension 20, is provided between the support surfaces 21 and 22 and is aligned with the slot 40 such that the nozzle 23a of the glue applicator 23 is positioned to apply cold glue along the inside of the fold line of the sheet 2. The glue is preferably applied as a line of individual dots of glue. It is to be understood, though, that hot glue, or a continuous line of glue may be applied in the alternative. Each folded sheet is then passed to the sheet collector 15.

The collector 15 allows one complete book (or book section) to accumulate in a stack before the book (or book section) is transported out of the collector 15 to the book finishing assembly. Leading into the collector is a carrier, preferably in the form of an elongate rod, which has a

low friction surface for engagement with the inner surfaces of the folded sheet adjacent to the fold line. The diameter of the carrier is selected so that the inside of the sheet fold line where the glue has been applied is supported away from and is not in contact with the upper surface of the carrier. The velocity of the sheets emerging from the sheet transport extension 20 is selected so as to be sufficient for the momentum of the sheets to cause the sheets to travel along the carrier to the collection or stacking area of the collector 15 without any further drive means or externally applied force.

The collection area extends downstream of the carrier and terminates at a back-stop 41. The back-stop 41 is preferably in the form of an upstanding plate which intersects the transport direction of at least the first sheet of every book (or book section) and acts to locate the leading edge of the sheet as the sheet is delivered to the collection area. The back-stop 41 is manually adjustable to permit the collection area to accommodate different book spine lengths. Alternatively, the position of the back-stop downstream of the carrier may be automatically adjusted under the control of a central control unit 24.

Mounted on the back-stop 41 is a retractable downstream finger 17 which is movable in the sheet transport direction between a first extended position in which the downstream finger 17 projects into the collection area from the back-stop 41 and a retracted position in which the downstream finger 17 lies flush with or downstream of the back-stop 41. Alternatively, although not illustrated, the retractable downstream finger may be rotatable about an axis substantially transverse to the sheet transport direction between the same first extended position and a second position in which the downstream finger 17 is substantially aligned with the plane of the back-stop 41.

The collector also includes a pair of retractable upstream blades 18 that are mounted beneath the carrier and are movable between a first extended position in which the upstream blades extend beyond the downstream end of the carrier to project into the collection area and a

second retracted position in which the upstream blades 18 preferably do not extend beyond the downstream end of the carrier. The upstream blades 18 are arranged substantially parallel but at an angle to each other and with a gap between them so that the upstream blades do not contact any glue that has been applied to the inner surface of the fold line of a sheet. It will, of course, be apparent, that the upstream blades 18 may be replaced by a finger similar to the downstream finger or that the downstream finger may comprise a pair of blades similar to the upstream blades illustrated in Figures 7a-7f.

The downstream finger 17 and the upstream blades 18 are arranged to cooperate so as to catch respective downstream and upstream edges of a folded sheet 2 as it travels past the end of the carrier into the collection area. Subsequent reciprocal retraction of the downstream finger 17 and the upstream blades 18 then causes the folded sheet to fall under gravity to start a new stack of sheets. The back-stop 41 is provided to halt the forward motion of the folded sheet and to locate the leading edge of the folded sheet in the desired stacking position. Similarly, the front-stop 42 is provided to locate the trailing edge of the folded sheet to ensure that as the sheets are stacked in the collection area, the sheets are in registry with one another.

A collection arm 16 is located in the collection area, immediately below the downstream finger 17 and the upstream blades 18, on which the individual sheets are stacked to form a book (or book section). A knock-up finger 43 is also provided on the back-stop 41 which acts to maintain the downstream registration of the sheets during stacking. Once the stack of sheets is complete, the knock-up finger 43 is movable out of the transport direction of the stack of sheets so that the stack of sheets may pass to the book finishing assemblies.

Figures 7a-7f illustrate the process of collecting a stack of sheets. In Figure 7a a completed stack of sheets has already been formed on the collection arm 16 and the first sheet of a new stack is shown travelling over the carrier leading into the collection area. As the stack on the collection

arm 16 is complete the downstream finger 17 and the upstream blades 18 are in their first extended positions and so project towards one another into the collection area. As the first sheet of the next stack arrives at the collection area (Figure 7b) the leading and trailing edges of the sheet engage with the downstream finger 17 and the upstream blades 18. At the same time, a pusher member 29 on a conveyor 19 engages with the upstream edge of the earlier stack of sheets on the collection arm 16 and urges the stack of sheets to travel away from the collection area towards the book finishing assemblies. Downstream movement of the stack of sheets causes the knock-up finger 43 to move so as to permit passage of the stack.

Accurate positioning of the first sheet of the next stack in the collection area is ensured by the engagement of the leading and trailing edges of the sheet with the back-stop 41 and the front-stop 42 (Figure 7c). The timing of the delivery of the sheets to the collection area is selected so that as the former stack of sheets leaves the collection area the second sheet of the next stack approaches the collection area over the carrier (Figure 7d)

Once the former stack of sheets is clear of the collection area, the knock-up finger 43 falls back to its registration position in which it provides downstream registration of the stacked sheets. At the same time, the downstream finger 17 and the upstream blades 18 are retracted (Figure 7e) so that the first sheet of the next stack, which has been temporarily supported by the finger 17 and the blades 18, is caused to fall under gravity onto the collection arm 16. The downstream finger 17 and the upstream blades 18 then remain retracted so that the second sheet for the stack falls directly over the first sheet which now rests on the collection arm 16 (Figure 7f). The same is repeated for subsequent sheets which successively arrive at the collection area until the stack is complete.

Thus, each sheet falls under gravity on top of the preceding sheet and every sheet 2 delivered into the collection area, apart from the first sheet of every stack, has glue applied to the inside of the fold line thereof,

as a result of its passage through the sheet transport extension 20 of the sheet folding assembly 10.

In a modification of this collector design, the upstream blades 18 (or finger) are dispensed with. The pusher member 29 is set to engage with the earlier stack so as to displace it at least slightly downstream before the first sheet of the new stack arrives in the collection area. The trailing edge of this new sheet is then free to fall under gravity onto the vacated upstream end of the collection arm 16, whilst its leading edge is supported by the extended downstream finger 17. The sheet remains in this position as the pusher member 29 completes removal of the earlier stack from the collection area. At this point, the downstream finger 17 is retracted as before and the first sheet completes its drop onto the collection arm 16.

A sensor 25 is positioned on the sheet conveyor 4 and is used to scan index markings (for example bar codes) printed on the sheets in order to identify the last sheet of a book (or book section). When the last sheet is identified by the sensor 25, after a short delay to allow the last sheet time to arrive at the collection area, the finger 17 and blades 18 are extended to catch the first sheet of the next stack whilst the existing stack of sheets is moved out of the collection area.

As can be seen from Figure 1 in particular, cover sheets 27, if used, simultaneously pass through the various stages of the process in a similar manner, either on top of one of the sheets 2 or in the gaps between sheets 2. Each cover sheet 27 may also have glue applied to the inside of its fold, and arrives in a position so that it can be laid over the top of the stack of sheets in the sheet collector 15.

The collector 15 further includes a pressing down anvil 28 which is shown more clearly in Figure 6. The anvil 28 is situated above the collection area and is positioned so as to be aligned with the fold lines of the sheets as they are stacked on the collection arm 16. The anvil 28 is movable downwardly to engage the spine of the fold lines of the sheets being stacked in the event there is an interruption in the input sheet stream. That is to say, in the event of an interruption in the sheet supply stream the

anvil 28 is moved to apply downward pressure to the fold lines of the sheets 2 to ensure full adhesive contact between individual sheets in the partial stack. The contacting surface of the anvil 28 is shaped so as to generally correspond to the V-shape of the folded sheets in the stack of sheets. Activation of the anvil 28 is initiated by the detection of an interruption in the supply of sheets to the collector 15. The detection of an interruption is preferably by means of a sensor upstream from the sheet folding assembly 10.

As mentioned earlier, once all the glued sheets of a book (including a separately fed cover, if applicable) are in place on the collection arm 16, the conveyor 19 moves forward and the pusher finger 29 projecting upwardly from the conveyor 19 to above the collection arm 16 engages the edge of the stack of sheets and pushes the stack forward off the collection arm 16 onto the saddle 33.

The cover feeder 26 is only required to be used when the cover to the book is in a different material, for example laminated, or is printed in colour whereas the remainder of the book is printed in monochrome. The cover feeder 26 has a table 30 on which the cover sheets 27 are stacked. From the table 30 a cover 27 is fed, using a vacuum separation system 39, in the stream of sheets so as to immediately follow the final sheet of a book and is then registered and centred with respect to the scoring wheels 5 in the usual manner. The cover is fed through the scoring wheels 5 to define a fold line for the cover and the scored cover is then fed to the folding belts 7, to the nip wheels 9 and then to the sheet transport extension 20 which applies glue to the inside of the fold in the cover 27 in a similar manner to that employed for applying glue to the individual sheets 2.

Alternatively, if a cover 27 is to be applied directly on top of the final sheet 2, then the underside of the cover 27 or the upper side of the final sheet 2 may receive a line of glue prior to the cover 27 and the final sheet 2 coming together as they enter scoring wheels 5.

In this way each cover 27 is folded, has glue applied to it and is introduced over the top of a stack of sheets in the collector 15. Sensors

(not shown) may be used to automatically monitor the size and shape of the covers so that the score line in the cover is accurately positioned centrally to the cover. Alternatively, fine adjustment may be performed manually.

The back-stop 41 and front-stop 42 in the sheet collector 15, plus the reciprocating knock-up finger 43 ensure the covers and the other sheets within each book are registered, preferably within 0.2 mm. The back-stop 41 is adjustable so that its position may be altered to accommodate different sheet and cover lengths. As mentioned earlier, adjustment of the back-stop may be performed manually or may be under the control of the central control unit 24.

The conveyor 19 moves the completed stack of sheets 2 (with a cover 27 if required) forward to the book presser 31 which presses the stack of sheets and the cover together along the spine of their aligned fold lines. The conveyor 19 then urges the stack of sheets 2 forward to a trimming assembly where the stack is trimmed to the requisite size and shape employing known techniques and apparatus.

The in-line binding apparatus and process described above enables the pages of a book or the pages of a section of a book to be securely held together by means of glue. In applying glue to the inside of the fold line of the folded sheet, the risk is significantly reduced of the glue accidentally being wiped by an adjacent sheet in comparison to a situation in which glue is applied to the outside of the fold line of the folded sheet. The reason for this is that the glue on the underside of an upper sheet will only contact the sheet below when the spine of the upper sheet settles on top of the spine of the lower sheet.

The apparatus and the process may be used for making both thick and thin glued books with digitally printed sheets. If the books are very thick then they will comprise a number of glued sections (with for example, six sheets per section) which are collected together and glued again (with hot glue) before the cover is applied. Thinner glued books may be made from one large section (up to fifty sheets for example, which are folded,

glued, and collected on top of one another with a cover on top).

In addition, the same process may be used for producing books in which the sheets 2 and cover 27 are bound together by the use of wire staples. In this case the cold glue nozzle 23 is inhibited and the book presser 31 is removed to be replaced with a wire stapling device. In this way books may be produced which are either glue bound or wire staple bound, both from the same machine.

Further and alternative features of the in-line binding process are envisaged without departing from the scope of the present invention as claimed.

CLAIMS

1. A process for binding sheets together, the binding process comprising the steps of:

feeding successive individual sheets to a folding apparatus;

folding each sheet along a fold line;

stacking successive sheets such that the fold lines of each sheet are substantially aligned

characterised in that adhesive is applied to the fold line of the second and subsequent sheets prior to stacking and in that the adhesive is applied to the inside of the fold line.

2. A process as claimed in claim 1, wherein after a sheet is folded the sheet is driven through an adhesive application station where the sheet is guided so that the inner surface of the fold line in the sheet pass over a slot in a supporting surface and wherein the adhesive is applied to the inner surface of the fold line through the slot.

3. A process as claimed in claim 2, wherein the fold line in the sheet is caused to pass over the slot in the supporting surface by means of driven rollers in or in contact with the supporting surface.

4. A process as claimed in any one of the preceding claims, wherein application of adhesive is inhibited when a sensor detects the first sheet of a new stack.

5. A process as claimed in claim 4, wherein the sensor is upstream of the adhesive application station and inhibition of the application of adhesive is delayed for a period corresponding to the time required for the sheet that has been identified as the first sheet of a new stack to reach the adhesive application station.

6. A process as claimed in any one of the preceding claims, further comprising introducing a cover into the stream of sheets being fed to the folding apparatus after the last sheet of a stack and before the first sheet of a new stack.

7. A process as claimed in any one of claims 1 to 5, further comprising applying adhesive to either the inner surface of a cover or the outer surface of the last sheet of a stack and adhering the cover to the last sheet of a stack prior to the last sheet of the stack being fed to the folding apparatus.

8. A process as claimed in any one of the preceding claims, further comprising transporting a complete stack of sheets to a finishing station and applying a compressive force to the spine of the aligned fold lines of the stacked sheets.

9. A process as claimed in any one of the preceding claims, further comprising applying a compressive force to the spine of the aligned fold lines of a stack of sheets in response to a detected interruption to the sheet feed.

10. A process as claimed in any one of the preceding claims, comprising temporarily inhibiting registration of a first sheet of a new stack on a stacking area whilst a complete stack of sheets is transported away from the stacking area.

11. A process as claimed in claim 10 wherein registration is inhibited by holding a leading edge of the first sheet above its position on the stacking area.

12. A process as claimed in claim 10 wherein registration is inhibited by holding the first sheet above the stacking area.

13. A process as claimed in any one of claims 10 to 12, further comprising releasing the first sheet or leading edge thereof to fall under gravity to the stacking area once the complete stack of sheets has cleared the stacking area.

14. Binding apparatus for binding sheets together, the apparatus comprising:

sheet folding apparatus for individually folding sheets along a fold line; and

a sheet collector for stacking successive sheets such that the fold lines of each sheet are substantially aligned

characterised by further comprising an adhesive applicator for applying adhesive to the inside of the fold line of the second and subsequent sheets prior to stacking.

15. Binding apparatus as claimed in claim 14, wherein the adhesive applicator is mounted in or adjacent a slot in a supporting surface and is arranged to deliver adhesive upwardly through the slot.

16. Binding apparatus as claimed in claim 15, wherein the supporting surface includes one or more driven rollers to urge passage of a sheet over the slot.

17. Binding apparatus as claimed in any one of claims 14 to 16, wherein the sheet collector comprises a stacking area with collection arm and a first retractable finger arranged above a downstream end of the stacking area.

18. Binding apparatus as claimed in claim 17, wherein the collector also comprises a second retractable finger, the retractable fingers being arranged above the stacking area.

19. Binding apparatus as claimed in claim 17 or 18, wherein at least one

of the retractable fingers is arranged for rotation about an axis substantially transverse to the sheet transport direction.

20. A process for stacking folded printed sheets, the process comprising the steps of:

feeding successive individual printed sheets to a folding apparatus;

folding each sheet along a fold line; and

stacking successive sheets such that the fold lines of each sheet are substantially aligned wherein the first sheet of a new stack is temporarily inhibited from registering on a stacking area by means of at least one retractable finger and characterised in that the at least one retractable finger is rotatable about an axis substantially transverse to the sheet transport direction.

21. A process as claimed in claim 20 wherein the first sheet is temporarily held by two retractable fingers, at least one of which is rotatable about an axis substantially transverse to the sheet transport direction.

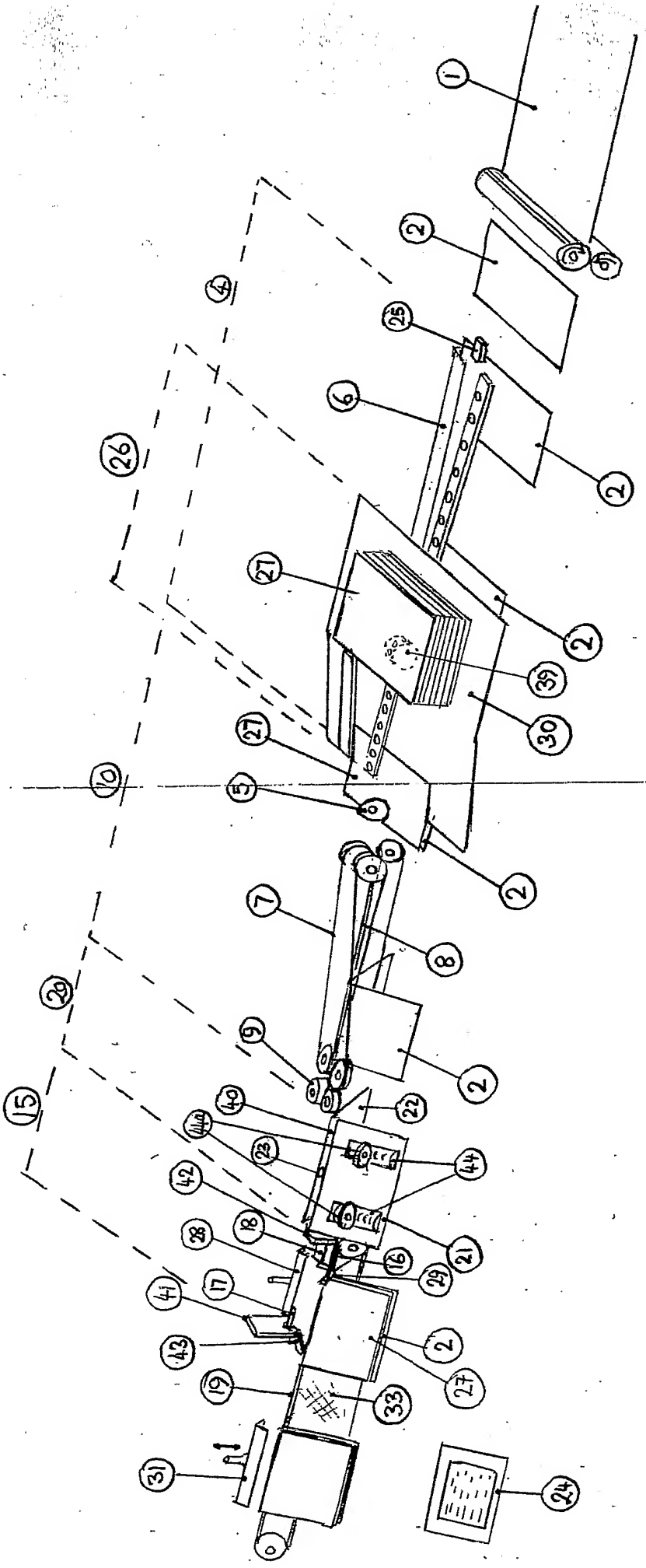
22. Stacking apparatus for stacking folded printed sheets together such that the fold lines of each sheet are substantially aligned, comprising a collection arm on which individual sheets are collected in a stack and at least one retractable finger arranged above at least a downstream end of the stacking area characterised in that at least one of the at least one retractable finger is rotatable about an axis substantially transverse to the sheet transport direction.

23. Stacking apparatus as claimed in claim 22 wherein the apparatus includes first and second retractable fingers arranged above the stacking area, at least one of which is rotatable about an axis substantially transverse to the sheet transport direction.

24. The stacking apparatus of claim 22 or 23, further comprising a

binding assembly for binding the stacked sheets together, the binding assembly being adapted to secure the individual sheets in a stack together by means of glue or wire.

FIGURE 1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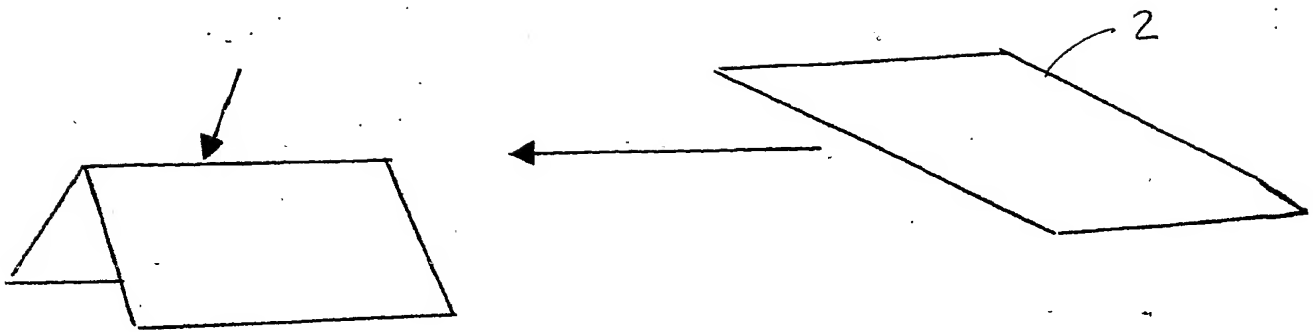

FIGURE 2

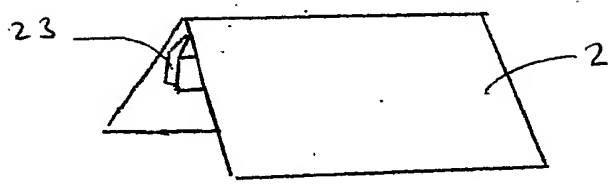

FIGURE 3

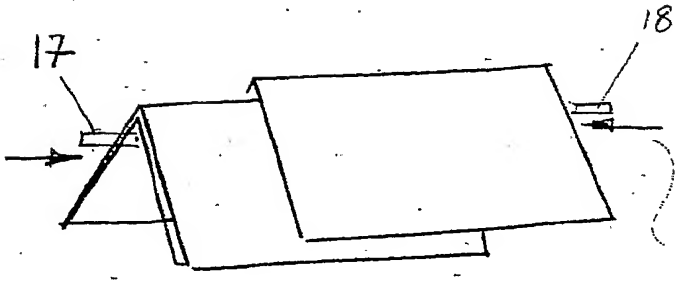

FIGURE 4

Arrows show direction of movement when extending.

FIGURE 5

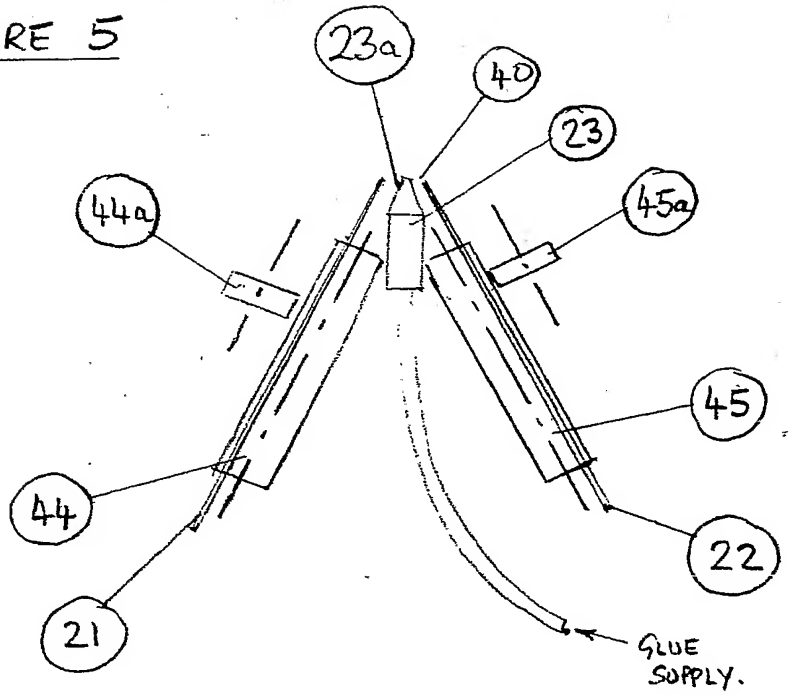

FIGURE 6

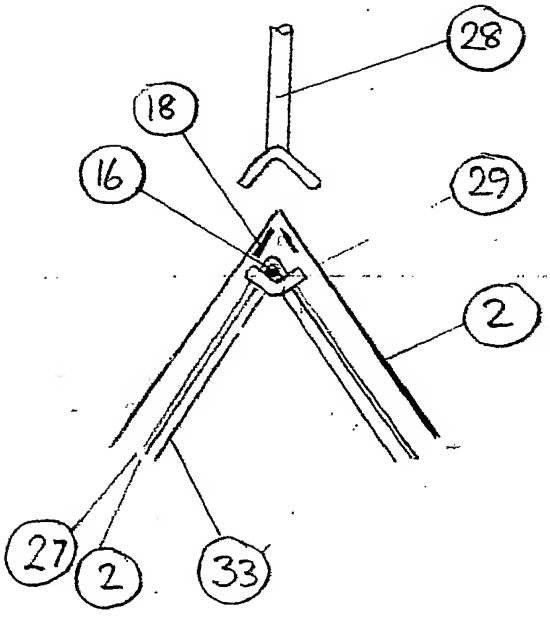

Figure 7a

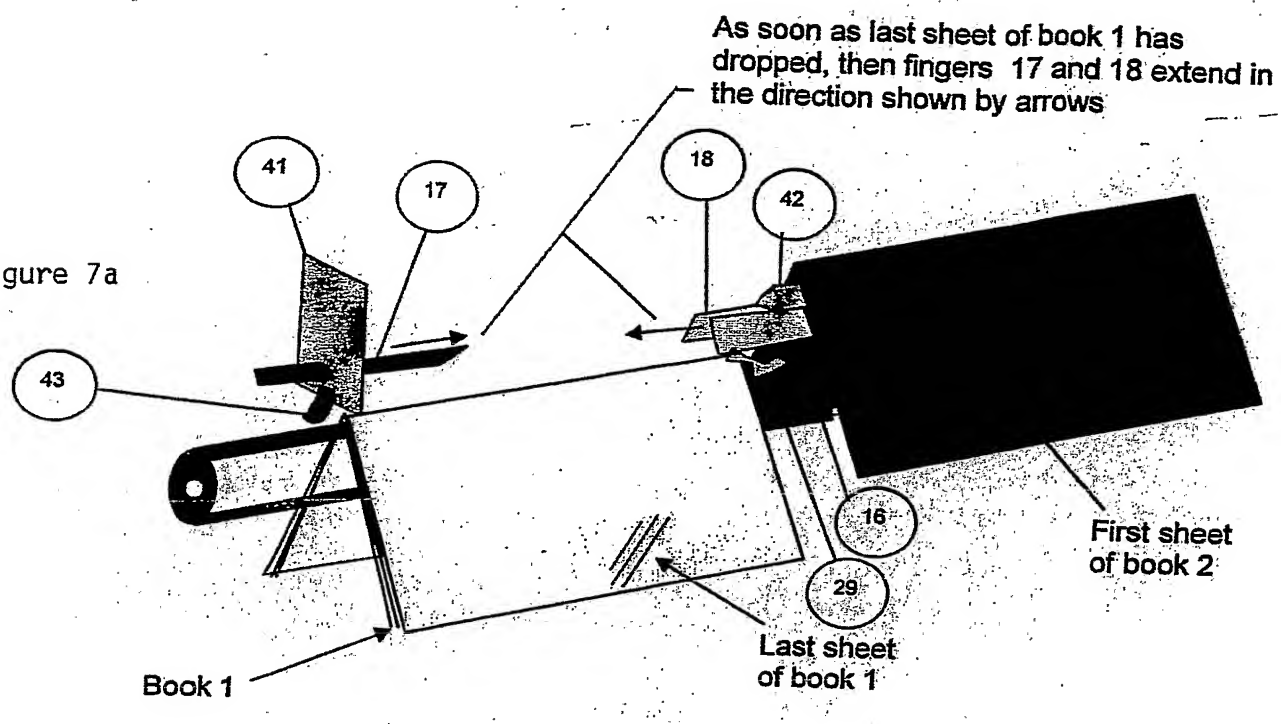

Figure 7b

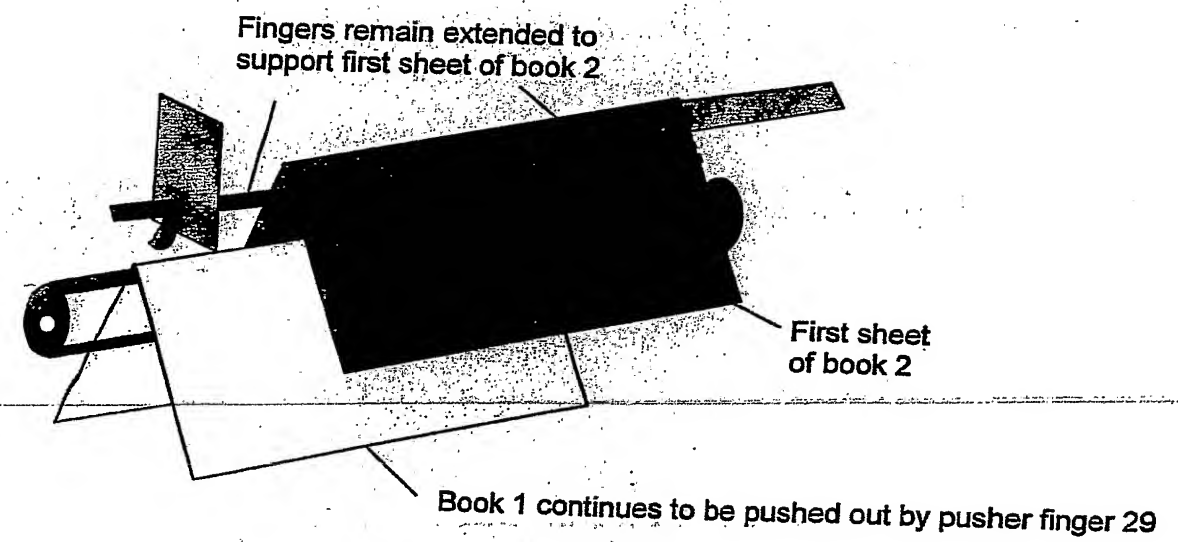

Figure 7c

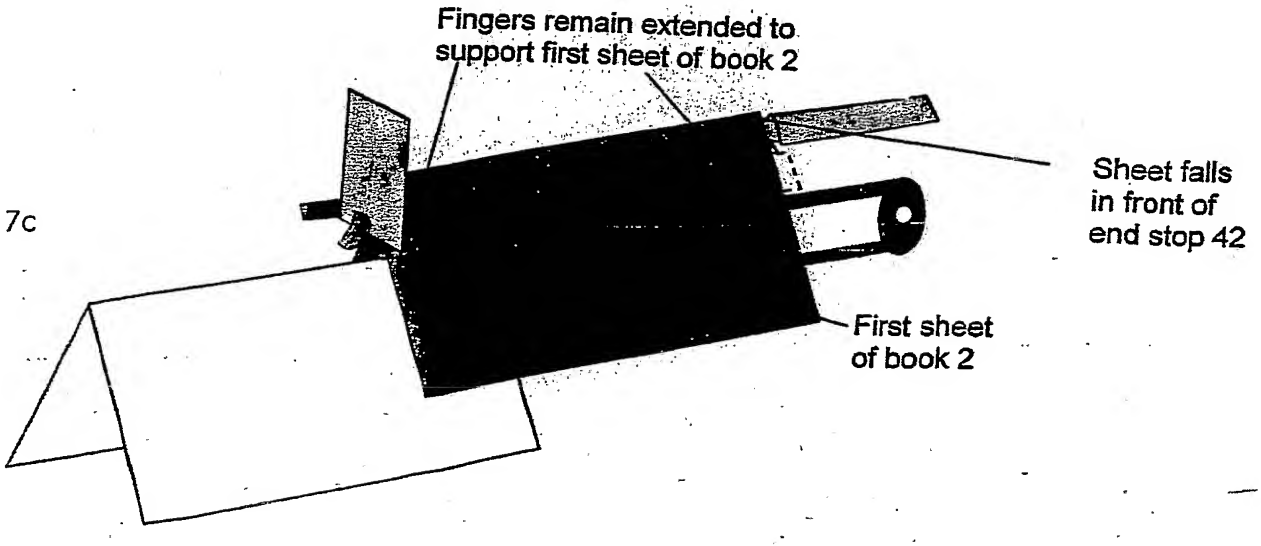

Figure 7d

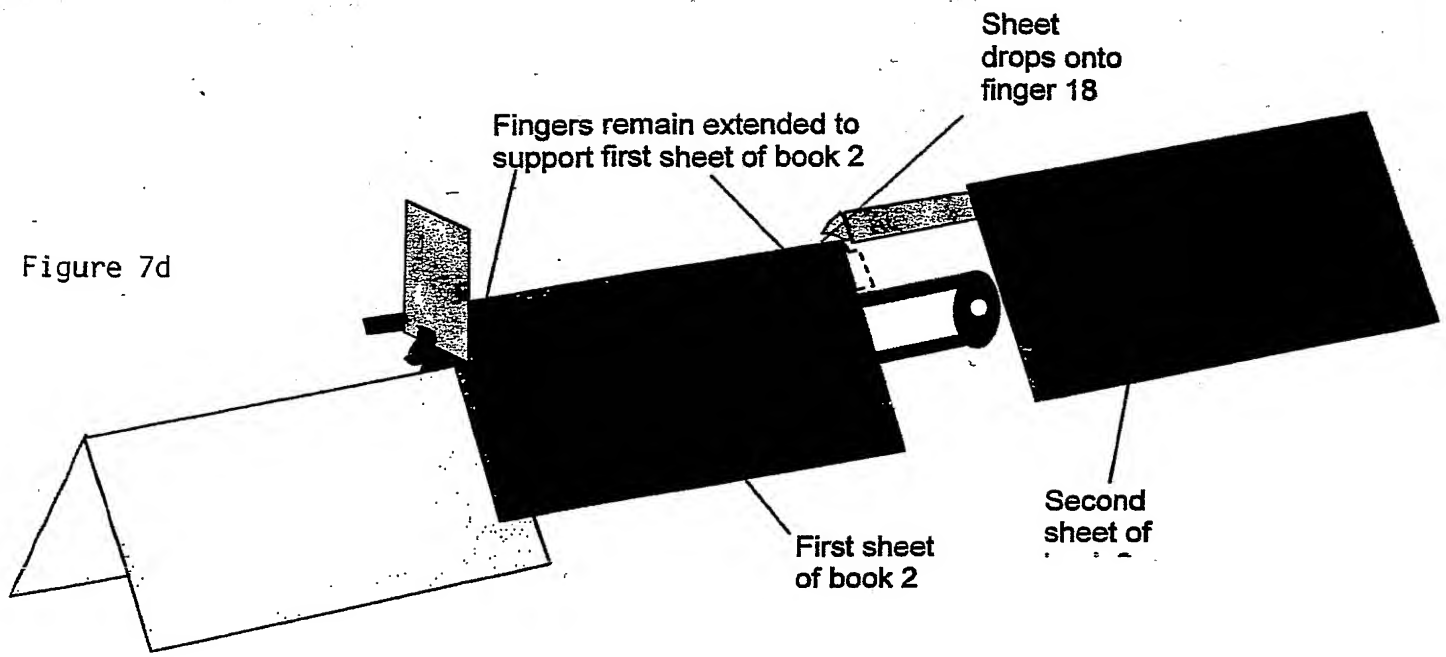

Figure 7e

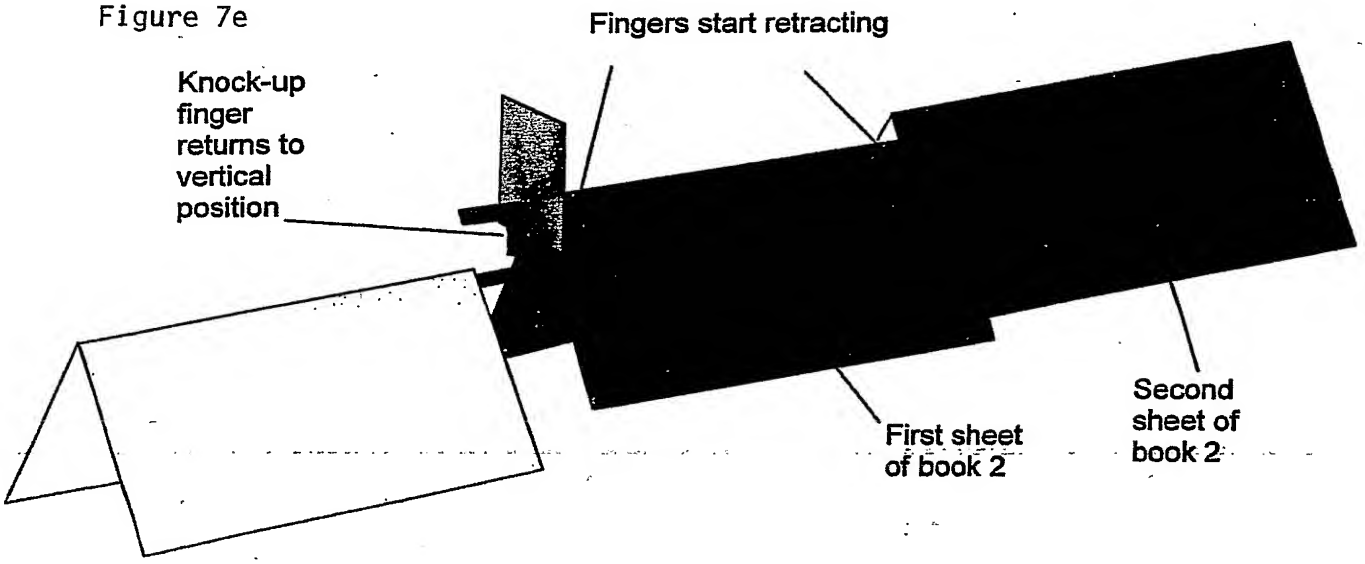

Figure 7f